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Then $\cot\beta=c/\sqrt{(d^2-c^2)}$.

$\cot\beta_1=ecot\beta=ec/\sqrt{(d^2-c^2)}$.

$\cot\beta_2=ecot\beta_1=e^2c/\sqrt{(d^2-c^2)}$.

.....

$\cot\beta_n=e^nc/\sqrt{(d^2-c^2)}=x/\sqrt{(d^2-x^2)}$.

$\therefore xcde^n/\sqrt{[d^2-c^2(1-e^{2n})]}$.

If $e=1$, $x=c$.

AVERAGE AND PROBABILITY.

102. Proposed by PROFESSOR CAVALLIN.

A random straight line is determined by two points taken at random within a sphere; find the average velocity acquired by a particle in descending the line. [No. 8742, *Educational Times*. Unsolved.]

Solution by G. B. M. ZERR, A. M., Ph. D., Professor of Chemistry and Physics, The Temple College, Philadelphia, Pa.

Let (x, y, z) , (u, v, w) be the coördinates of the two random points with center of sphere as origin. Let a =radius, $\sqrt{(a^2-x^2)}=y'$, $\sqrt{(a^2-u^2)}=v'$, $\sqrt{(a^2-x^2-y'^2)}=z'$, $\sqrt{(a^2-u^2-v'^2)}=w'$. The elevation of the one end of the line above the other= $(u-x)$.

Velocity= $\sqrt{[2g(u-x)]}$. The limits of x are $-a$ and a ; of u , x and a and doubled for the case when $u < x$; of y , $-y'$ and y' ; of z , $-z'$ and z' ; of v , $-v'$ and v' ; of w , $-w'$ and w' . Then since $(\frac{4}{3}\pi a^3)^2$ is the number of ways the two points can be taken, we get

$$\begin{aligned}\Delta &= \frac{2}{(\frac{4}{3}\pi a^3)^2} \int_{-a}^a \int_x^a \int_{-y'}^{y'} \int_{-z'}^{z'} \int_{-v'}^{v'} \int_{-w'}^{w'} \sqrt{[2g(u-x)]} dx du dy dz dv dw \\ &= \frac{9\sqrt{2g}}{8a^6} \int_{-a}^a \int_x^a \sqrt{(u-x)(a^2-x^2)(a^2-u^2)} dx du \\ &= \frac{3\sqrt{2g}}{35a^6} \int_{-a}^a (5a+2x)(a^2-x^2)(a-x)^{\frac{5}{2}} dx\end{aligned}$$

Let $x=a\cos\theta$.

$$\therefore \Delta = \frac{192\sqrt{ag}}{35} \int_0^\pi (7-4\sin^2\frac{1}{2}\theta)\sin^{\frac{3}{2}}\theta\cos^{\frac{5}{2}}\theta d\theta = \frac{256\sqrt{ag}}{273}.$$

103. Proposed by LON C. WALKER, A. M., Assistant Professor of Mathematics, Leland Stanford Jr. University, Palo Alto, Cal.

A circle is drawn at random both in magnitude and position, but so as to lie wholly on the surface of a given semi-circle. Show that the chance that a